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October 05, 2000

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APPLICATION NUMBER: *09/412,764*
FILING DATE: *October 01, 1999*

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

N. WILLIAMS
Certifying Officer

DOCKET NO: **610P002**

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: **Kevin Mark Powell**

Serial No.: **Not yet assigned**
Group Art Unit: **Not yet assigned**
Filing Date: **Herewith by Express Mail**
Examiner: **Not yet assigned**

For: **EXPLOSIVE DEVICE PARTICULARLY FOR AVALANCHE CONTROL**

EXPRESS MAIL LABEL NO.: **EJ861863908US**
DATE OF DEPOSIT: **October 1, 1999**

BOX: __X__ Patent Application

____ Provisional _____ Design ____ Sequence

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

PATENT APPLICATION TRANSMITTAL LETTER

Transmitted herewith for filing, please find:

__X__ A Utility Patent Application.

If this is a continuing application, please check appropriate box:

____ Continuation ____ Divisional _____ Continuation-in-part of prior application U.S. Serial No. _____ filed _____

____ A Design Patent Application.

DOCKET NO: **610P002**

Including the following:

____ Provisional Application Cover Sheet.

____ New or Revised specification, including pages _____ containing:
____ Specification
____ Claims
____ Abstract

___ A copy of earlier application Serial No. _____ Filed _____ ~~to which no new matter has been~~ added, TOGETHER WITH a copy of the executed oath or declaration for such earlier application and all drawings and appendices. Such earlier application is hereby incorporated into the present application by reference.

____ A copy of executed oath or declaration for earlier application Serial No. _____ Filed _____. The entire disclosure of such earlier application is considered as being part of the disclosure of the present application and is hereby incorporated into the present application by reference.

____ Please enter the following amendment to the Specification under the Cross Reference to Related Applications section (or create such a section): **"This application ..."**

____ Signed Statement attached deleting inventor(s) named in the prior application.

____ Preliminary Amendment is enclosed.

__X__ **SIX (6)** Sheet(s) of Drawings.

____ Petition to Accept Photographic Drawings.
____ Petition Fee

__X__ An _____ Executed __X__ Unexecuted Declaration or Oath and Power of Attorney.

____ An Associate Power of Attorney.

____ An Executed Assignment of the Invention to:
_____

_____ A Recordation Form Cover Sheet.

_____ Recording Fee - $40.00.

DOCKET NO: **610P002**

____ Priority is claimed under 35 U.S.C. §119 of _____ patent application no: _____ filed _____ in _____

A certified copy of the foregoing application for which priority is claimed:

____ is enclosed.

____ will be submitted in due course

____ was filed in prior application Serial No. filed .

____ was transmitted by the International Bureau under International Application No. filed

____ An _____ Executed ____ Copy of Earlier Statement Claiming Small Entity Status under 37 C.F.R. 1.9 and 1.27

____ is enclosed.

____ has been filed in prior application Serial No. _____ filed _____, said status is still proper and desired in present case.

____ Diskette Containing DNA/Amino Acid Sequence Information.

____ Statement to Support submission of DNA/Amino Acid Sequence Information.

____ Letter of Reference to Computer Readable Form.

____ Information Disclosure Statement.

____ Attached Form 1449.
____ Copies of each of the references listed on the attached Form PTO-1449 are enclosed herewith.

____ Petition for Extension of Time for parent application, Together with the appropriate extension fee.

____ Appended Materials as follows: _____.

__X__ Return Receipt Postcard specifically itemized.

____ Other as follows:

DOCKET NO: **610P002**

FEE CALCULATION	**BASIC FEES**
Provisional Application	$150.00
Design Application	$310.00
Utility Application	$760.00

For	Number Filed	Number Extra	Rate	Fee
Basic Fee				$ 760.00
Total Claims	16 - 20	0	x $18.00 =	$ 0.00
Independent Claims	4 - 3	1	x $78.00 =	$ 78.00
Multiple Dependent Claims			+ $260.00 =	$ 0.00
		TOTAL FILING FEES		$ 838.00
		1/2 SMALL ENTITY FEE	=	**$ 419.00***

The Filing Fee will be submitted in due course, together with the executed Declaration and the surcharge for late filing.

____ A Check is enclosed in the amount of _____.

____ The Commissioner is authorized to charge payment of the following fees and to refund any overpayment associated with this communication or during the pendency of this application to deposit account _____. This sheet is provided in duplicate.

____ The foregoing amount due.

____ Any additional filing fees required, including fees for the presentation of extra claims under 37 C.F.R. 1.16.

____ Any additional patent application processing fees under 37 C.F.R. 1.17 or 1.20(d).

____ The issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance.

DOCKET NO: **610P002**

SHOULD ANY DEFICIENCIES APPEAR which respect to this application, including deficiencies in payment of fees, missing parts of the application or otherwise, the United States Patent and Trademark Office is respectfully required to promptly notify the undersigned.

Date: October 1, 1999

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Kevin Mark Powell
Serial No.	:	Not yet assigned
Filed	:	Herewith by Express Mail
For	:	EXPLOSIVE DEVICE PARTICULARLY FOR AVALANCHE CONTROL
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Art Unit	:	Not yet assigned
Attorney Docket No.	:	610P002
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"EXPRESS MAIL" MAILING LABEL NO. **EJ861863908US**
DATE OF DEPOSIT: **October 1, 1999**

I hereby certify that this patent application is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to: Assistant Commissioner of Patents and Trademarks, **BOX: PATENT APPLICATION,** Washington, D.C. 20231.

Ann Marie Mahan
Name of person mailing paper or fee

Signature of person mailing paper or fee

EXPLOSIVE DEVICE PARTICULARLY FOR AVALANCHE CONTROL

This invention relates to explosive devices commonly referred to as hollow charges or shaped charges. These essentially comprise a symmetric explosive charge within which is formed a cavity lined by a lining material. When the explosive charge is detonated the liner, of metal in known devices, is subject to extremely high compressive loads which act to collapse and eject the liner material in the form of a high speed fluid jet, normally followed by a more slowly moving rigid slug. The charge and liner may be rotationally symmetric or non axi-symmetric, for example with a liner with a "V" cross section, used for cutting operations.

There are a number of industrial applications for shaped charge devices where rapid penetration effects are required in awkward and inaccessible places. An example is to initiate or increase the yield of oil & gas wells. In this case a number of charges are arranged to fire radially outwards at the base of the well. Upon detonation the shaped charge jets perforate the steel well casing, surrounding concrete grouting and then penetrate deeply into the oil/gas bearing rock, producing a series of discrete channels through which the oil and gas can flow into the well conduit. Another application is perforation and clearance of refractory bung at the base of a steel smelting crucible. The most extensive use, however, is in the military context against heavily protected targets such

as tanks and shelters and for a wide range of battlefield engineering applications. In all these cases the shaped charges are designed and applied to exploit their penetration potential.

The present invention seeks to provide a shaped charge explosive device particularly suitable for use for avalanche control. However, the mechanism by which energy is distributed and imparted to the target medium by this invention offers potential for a number of alternative applications. The invention will be described in context with avalanche control applications first, followed by alternative applications.

Avalanches can present a serious danger to people and property when triggered in an uncontrolled manner, whether by a natural cause such as the weather conditions or unintentionally as a result of human activity such as skiing or climbing. It has therefore become an established practice in many mountainous areas to maintain a continuous programme of avalanche control using explosives to trigger a release. This practice of regularly triggering small controlled avalanches is intended to minimise the build up of snow in known start zones which, if left, would eventually release naturally and unexpectedly often cascading out of control. The current practices relevant to the present invention include the following.

Where avalanche start zones are inaccessible, an explosive charge can be delivered to the slope in the form of a projectile fired from a gun or mortar system where the

projectile explodes on or shortly after impact. Short ranges (up to 3km) can be covered by gas gun projector systems such as the nitrogen driven Avalauncher, used extensively in the US, Canada and Europe. Longer ranges demand high performance systems typical of military artillery and the 105mm howitzer and 106mm recoilless rifle have been used in avalanche control operations for many years.

Fuzes in older military ammunition are designed to detonate upon impact, in soft snow, however, these fuzes tend to trigger well below the surface and quite probably not until the projectile strikes rock or firm ground. In fact, the ideal point of burst for avalanche release is several metres above the surface in proximity mode. However, with gun fired projectiles, this can only be achieved with an electronic proximity burst fuze. Since this type of fuze is both inhibitively expensive and notoriously unreliable against light, dispersed media such as snow, the performance of impact fuzing continues to be tolerated.

Most areas in ski resorts are accessible, including the mountain peaks, and this accessibility enables explosive charges to be delivered or placed by hand. The practice of positioning charges by hand is probably the most cost effective and extensively used method of avalanche control in many ski resorts, but carries with it obvious hazards in poor weather conditions. The hand charge is a relatively simple device consisting of a lightly cased (cardboard)

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explosive charge detonated by a length of capped pyrotechnic delay fuze. The fuze can be ignited and the charge thrown into a preferred position or the charge can be pre-positioned above the surface on a bamboo stick before the fuze is ignited.

It is acknowledged that various types of anti-tank ammunition, bearing shaped charge liners, have been fired into avalanche start zones in the past but this has been as a result of ammunition availability rather than an interest in the shaped charge effect. Results from this type of ordnance, designed specifically for high penetration into steel, has nevertheless been no different from standard artillery fragmenting shells because little of the jet energy can be dissipated into the snow pack.

The present invention seeks to provide an improved hollow charge explosive device for this and other applications.

Accordingly, the present invention provides a hollow charge explosive device including an explosive charge defining a cavity and a liner lining the said cavity, said liner including a particulate material so as to be dispersible by said explosive charge when detonated.

The particulate material is driven in the same way as that of a conventional shaped charge liner. However, in this case, the particulate medium forms into a highly energetic non-cohesive stream of particles, generally wider than that produced by a conventionally lined shaped charge. In this highly energised state, the low bulk density of the

liner material and high surface area attributable to each particle of the liner material, together with the larger surface area of the jets cross section, facilitates an intimate and violent kinetically stimulated reaction with the target medium. Given a knowledge of the intended target material and its constitution, eg a snow slab, the liner material can be chosen to optimise the blast energy yield over and above that normally attributable to the explosive charge alone.

Conveniently, the liner may comprise an inner liner skin and an outer liner skin defining a space therebetween and the particulate material may be a loose powder contained in that space. In a preferred embodiment, the inner liner skin and outer liner skin are of a glass reinforced plastics material. The particulate material may be aluminium powder, particularly for use in avalanche control due to the potentially highly reactive nature of aluminium powder with water.

In an alternative embodiment, the particulate material may be embedded in an inert binder such as a plastics material or an adhesive matrix to aid manufacture, handling and assembly. The matrix material may also be conveniently chosen to make a nett contribution to the reaction of the principal suspended particulate material.

Alternatively, the particulate material may be embedded in a solid binder.

An explosive device assembly may be formed from two such explosive devices oriented such that the jets of liner

formed on detonation of the charges are directed towards each other or away from each other.

When the jets are directed toward each other, the collision of the liners with each other provides an energetic response between the interacting liners. Two or more dissimilar liner materials may be provided in the explosive devices which when brought together in collision with each other and/or the target medium achieve an energetic response between associated interacting materials.

The devices may be gun fired, or otherwise hand thrown, or form part of a mechanically or chemically launched projectile.

An elongate support may be attached to the explosive charge body to aid hand positioning the device at the target.

The liner material may take any convenient form which can produce a shaped charge liner collapse mechanism and typically include linear liner configurations and hemispherical and hemispherical cap geometries.

A method of triggering an avalanche according to the present invention comprises positioning an explosive device or explosive device assembly of the present invention in a predetermined position relative to a snow or ice formation and detonating said explosive device or device assembly.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings of which:

Figure 1 is a diagrammatic sectional view of a first

device according to the present invention;

Figure 2 is a diagrammatic sectional view of a second device according to the present invention;

Figures 3, 4 and 5 show the results of recent experimental cratering trials conducted against level and stable snow pack;

Figures 6 to 8 illustrate an explosive device which is as device of Figure 1 but with a support stick affixed to it;

Figure 9 shows a further embodiment of the present invention for cornice control;

Figure 10 shows a further embodiment of an assembly comprising two devices of Figure 1;

Figure 11 shows a typical application of the device of Figure 10 for avalanche control;

Figure 12 shows a further embodiment of an assembly comprising two devices of Figure 1;

Figure 13 shows a typical application for the device of Figure 12 for avalanche control;

Figure 14 shows an embodiment of the invention within the body of a modified Avalauncher gas gun round; and

Figure 15 shows a modular application of the explosive charge assembly of Figure 14.

Referring to Figure 1, and explosive device 10 consists of a cylindrical GRP body 2 located between a perspex magazine locating plate 4 and perspex liner locating plate 6. The magazine locating plate 4 centralises a perspex magazine unit 8 on the central axis of the device. The

magazine unit 8 locates a detonator 12 and explosive booster pellet 14 to form an initiation cap assembly 16. The initiation cap assembly 16 ensures that the detonation front transferred into a main explosive filling 18, via the booster pellet 14, is propagated symmetrically with respect to the axis of the device 10. A GRP outer liner skin 22, with an open truncated apex 24 is bonded to the cylindrical body 2 to form a sub-assembly 26. An internal GRP conical liner 32, with a closed truncated apex, is bonded into the recess 34 machined into the liner locating plate 6 to form a sub-assembly 36. Sub-assemblies 26 and 36 are then joined and bonded to form a charge assembly 42 defining a conical void 44 concentric and aligned to the central axis of the device 10.

The material and grist size of a particulate liner cavity filling 45 is chosen to suit the nature of the target material involved. For avalanche control work, aluminium powder of 150 micron particle size is suitable, for example. The filling 45 is loaded into the void 44 through a filling port 24 at the apex of the liner 22. The filling port is then sealed with a disk of aluminium adhesive tape 46. The explosive filling 18 is then loaded into the charge assembly 42 and the charge is closed by fitting and bonding the initiation cap 16 in place. A hole 48 in the liner locator plate 6 allows pressure equalisation between the conical void enclosed by the inner liner skin 32 and liner locator plate 6 and external atmospheric pressure and has no other bearing on the function of the device.

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Referring now to Figure 2, an device 20 consists of a cylindrical body 50 located between an initiation cap 16 and a perspex tubular liner assembly locator plate 35. The initiation cap 16 ensures that the detonation front is transferred into a radial detonation transfer disk 51, symmetrically disposed with respect to the axis of the device 20. An inner GRP tubular liner 52 and outer GRP tubular liner 53 are located co-axially between a polyethylene barrier plate 59 and the tubular liner assembly locator plate 35. The separation between the two tubular liners 52 and 53 is maintained by an insert 54 which is drilled with a single hole 55 to allow a void 56 defined by the liners 52 and 53 to be filled with aluminium powder 58.

The barrier plate 59, inner and outer tubular liners, 52 and 53 respectively, and insert 54 are bonded together to form a tubular liner assembly 57, The void 56 between the inner and outer tubular liners is filled with aluminium powder 58, of 150 micron particle size, through the filling hole 55 which is then sealed with a disk of aluminium adhesive tape, (not shown). The radial detonation transfer disk 51 is bonded to the inner face 58 of the initiation cap assembly 16 and the barrier plate 59 of the tubular liner assembly 57 is bonded concentrically to the outer face 62 of the radial detonation transfer disk 51. A main explosive filling 64 is filled into the charge assembly from the open end opposite the initiation cap 16 and closed and sealed by fitting and bonding the tube locator plate 34 in position.

Figure 3, 4 & 5 show the results of experimental

cratering trials of the explosive device of Figure 1 conducted against a level and stable snow pack 66. Each charge was set 1.2m below the snow surface such that its axis was horizontal and the point of detonation 68 arranged such that any bias would be driven in the direction of the arrow. After firing, the craters were sectioned to reveal the profiles shown in the figures. The depth of the snow base is indicated by a solid black line 72

The profile 74 shown in Figure 3 was produced by a 1kg blast explosive charge 70. The charge was 68 fired to establish a control standard against which the experimental charge firings of devices according to the present invention could be compared. The profile was symmetrical about the vertical axis and yielded a crater volume of 2.7 cubic metres.

The profile 76 shown in Figure 4 was produced by the device 10 described earlier and shown in Figure 1. The explosive content was also 1kg. The effects of the conical liner are clear. The crater was elongated as a result of the penetration and subsequent secondary reaction of the shaped charge jet. A significant increase in the energy transmission into the snow pack was evident, the crater volume increasing from 2.7 to 11.9 cubic metres.

The profile 78 shown in Figure 5 was produced by the device 20 described earlier and shown in Figure 2. The explosive content was also 1kg. This liner configuration produced more localised reaction of the liner material. The crater volume was increased from 2.7 to 7.8 cubic metres.

This was less than that produced by the conical liner configuration of device 10 but particularly high shock emission was evident from the ground shock detected and extensive secondary surface spalling at the inner surface of the crater.

There will now be described exemplary applications of the device 10 of Figure 1. It should be note that the applications are equally valid for the device 20 of Figure 2 and liner geometries that fall between the two, the choice being made to suit the characteristics of the particulate loading material, operational environment, cost, and target medium involved.

Figures 6 to 8 illustrate the use of an explosive device 40 which is as device 10 of Figure 1 but with a support stick 82 affixed to it so the device can be positioned and orientated as required on a snow slab. The device 40 includes a pyrotechnic fuze 88. The highly focused blast emission produced by the enhanced blast charge 10 is indicated schematically by the extended, highly schematic "star" shaped blast envelope 84. They respectively illustrate the use of the device for cornice overhang removal with the device 40 providing combined air shock and deep penetration, slab blasting with the device providing combined air shock and deep penetration perpendicular to the snow slab, and slab blasting where the device is orientated to provide superficial disruption of the surface layer of a snow slab.

Figure 9 shows a further use of the present invention

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for cornice control. The device 50 is as the device 10 of Figure 1 but includes a pyrotechnic fuze 88 and a conical end cap 86 to aid penetration into the soft back of the cornice following remote delivery of the device from a short range launcher system, typically a cross bow.

Figure 10 shows a further embodiment of the present invention, namely an assembly 60 comprising two devices 10 of Figure 1, located back to back within a thin cardboard tube 92. A smaller diameter cardboard tube 94, located inside the main tube 92, holds the devices apart and tape 96 at each end retains the two devices 10 in place. Each device 10 is connected to an identical length of shock tube 98 (Dyno-Nobel Starter Line), terminated at the charge end by an instantaneous standard detonator cap 102. The starter lines 98 pass out of the locating tubes 92 and 94 via hole 104 and are fixed securely to the outer tube 92 by adhesive tapes 106.

The assembly 60 of Figure 10 produces a simultaneous detonation of the charges 10 which project a highly focused axi-symmetric blast wave travelling in opposite directions along the axis of the assembly as indicated by the blast envelope 99.

Figure 11 shows a typical application for the device 60 of Figure 10 for avalanche control. The assembly 60 is arranged to overhang a cornice build up such that the axis of the charge is parallel to the line of the cornice. The two starter lines 98 are initiated simultaneously from a firing point 70 in known manner.

Figure 12 shows a further embodiment of the present invention, namely an assembly 80 comprising two devices 10 of Figure 1, located face to face within a thin cardboard tube 108. A smaller diameter cardboard tube 112, located inside the main tube 108, establishes a separation between the charges 10 that can be changed in length to alter the output of the charge assembly. The charges 10 are retained in the outer tube 108 by adhesive tape as described for Figure 10. Each device 10 is connected to an identical length of shock tube 114 (Dyno-Nobel Starter Line), terminated at the charge end by an instantaneous standard detonator cap 116. The two starter lines are then crossed over the outer tube 108 and taped securely as described for Figure 10.

The assembly 80 of Figure 12 produces simultaneous detonation of the charges. When the jets formed by the two shaped charge liners collide, in accordance with simple principles of momentum balance, a symmetrical 360 degree disk of high pressure products 109 is emitted in a plane at 90 degrees to the axis of the two charges.

Figure 13 shows a typical application for the device of Figure 12 for avalanche control. The assembly 60 is arranged to overhang a cornice build up such that the axis of the charge is parallel to the line of the cornice. The two starter lines 98 are initiated simultaneously from the firing point 70. This arrangement may be equally effective if suspended such that the axis of the assembly 80 runs vertically.

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Figure 14 shows an embodiment 90 of the current invention within the body of a modified Avalauncher gas gun round 90. An assembly 125 consists of a plastics nose cone 118, a full calibre body shell 119, containing the explosive filling 122, and an enhanced blast shaped charge liner assembly 123, as described for device 10 of Figure 1, and a plastics tail fin adaptor 124 of known form. The explosive charge assembly 125 is stored separately from a known tail fin assembly 126, which embodies the safety and arming mechanism (not detailed) and detonator 128. This configuration significantly improves the performance of the standard Avalauncher blast round as shown in Figures 3 and 4, respectively.

Figure 15 shows a further embodiment 100 employing the above explosive charge assembly 125 but this time in conjunction with the shock tube firing and control system described in detail filed in copending British Patent Application No 9915586.3 the entire contents of which are incorporated by reference into this application. This embodiment 100 is a cost effective engineering solution, for application of the experimental configurations described in Figures 1 and 2, to hand charge avalanche control operations. Briefly, the free end 132 of a Dyno-Nobel starter line is attached to the operator (not shown). The remainder of the starter line is coiled as a coil 134 within a cardboard spool tube 136, eventually terminating at a detonator end 138 forming a spool assembly 142 which is retained 144 on the body of the Avalauncher explosive charge

assembly 125 by adhesive tape 144. The charge assembly 100 may be thrown or launched to the desired position, the first end 132 of the starter line being subsequently detached from the operator and connected to a firing pack (not shown) ready for firing.

Although the use of present invention has been described in terms of avalanche control applications, the benefits of controlled and highly directional cutting, perforation or stimulation of secondary reactions of explosive devices according to the present invention has a wide range of other potential applications. These include:

rapid generation of wide access holes in concrete/rock walls in support of rescue and recovery operations, where a range of liner materials and particle sizes for the liner can be chosen to control the nature of the cut and/or residual particle penetration into sensitive areas behind;

the use of directing the highly focused blast effects to combat and extinguishing burning oil wells;

rapid internal cutting of narrow bore, thick walled pipes, typical of well liners and drilling shafts; and

spalling of loose rock from chamber roofs in underground mines, civil tunnelling and mining operations and underwater engineering operations.

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention

as defined by the appended claims.

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CLAIMS

1. A hollow charge explosive device, particularly for avalanche control, including an explosive charge defining a cavity and a liner lining said cavity, said liner including a particulate material so as to be dispersible by said explosive charge when detonated in which said liner comprises an inner liner skin and an outer liner skin spaced apart from said inner liner skin, said inner liner skin and said outer liner skin formed from a glass reinforced plastics material, and said particulate material is a loose aluminium powder located between said inner liner skin and said outer liner skin.

2. A hollow charge explosive device including an explosive charge defining a cavity and a liner lining the said cavity, said liner including a particulate material so as to be dispersible by said explosive charge when detonated.

3. A device as claimed in claim 2, in which said liner comprises an inner liner skin and an outer liner skin spaced apart from said inner liner skin, and said particulate material is a loose powder located between said inner liner skin and said outer liner skin.

4. A device as claimed in 3 in which said inner liner skin and said outer liner skin are formed from a glass reinforced plastics material.

5. A device as claimed in claim 2, in which said particulate material is embedded in a solid binder.

6. A device as claimed in claim 2, in which said particulate material has been consolidated by mechanical pressure.

7. A device as claimed in claim 2 in which said particulate material is aluminium powder.

8. A device as claimed in claim 2 in which said particulate material is a chemical or is a composition which reacts with a predetermined target medium.

9. An explosive device assembly including two explosive devices, each as claimed in claim 2, said two explosive devices being oriented such that the jets formed from said liners on detonation of the charges are directed towards each other.

10. An explosive device assembly including two explosive devices, each as claimed in claim 2, said two explosive devices being oriented such that said jets formed from said liners on detonation of said devices are directed away from each other.

11. An explosive device assembly as claimed in claim 9 in which the collision of said liners with each other provides

an energetic response between the interacting liners.

12. An explosive device assembly as claimed in claim 11 said liners being formed from dissimilar materials, said materials being such that when brought together in collision with each other and/or a target medium an energetic response between associated interacting materials is achieved.

13. An explosive device as claimed in claim 2 which is embodied in a gun firable or hand throwable, or mechanically or chemically launchable projectile.

14. A method of triggering an avalanche comprising providing an explosive device comprising a hollow charge explosive device, including an explosive charge defining a cavity and a liner lining said cavity, said liner including a particulate material so as to be dispersible by said explosive charge when detonated in which said liner comprises an inner liner skin and an outer liner skin spaced apart from said inner liner skin, said inner liner skin and said outer liner skin formed from a glass reinforced plastics material, and said particulate material is a loose aluminium powder located between said inner liner skin and said outer liner skin, positioning said explosive device in a predetermined position relative to a snow or ice formation, and detonating said explosive device.

15. A method as claimed in claim 14, in which said

explosive device is positioned by launching said explosive device by hand or by mechanical or chemical propulsion.

16. A method of blasting a target including a given material comprising, providing an explosive device including an explosive charge defining a cavity and a liner lining the said cavity, said liner including a particulate material so as to be dispersible by said explosive charge when detonated, said particulate material being selected to be one which reacts with the said material of the target on detonation of the explosive device, and detonating said explosive device.

ABSTRACT (Ref. Figure 1)

Explosive Device Particularly for Avalanche Control

A shaped charge explosive device (10) comprising an explosive charge body including an explosive charge (18) defining a cavity and a liner lining the cavity, the liner including a particulate material (44) dispersible by the explosive charge when detonated. In a preferred embodiment of this device of particular applicability to use in avalanche control, the particulate medium is aluminium. This is energised by the liner collapse and jetting process such that on impact and interaction with a snow/ice target it generates a directed blast effect extending beyond that achievable with a simple blast charge of the same mass. Direct application to hand charge avalanche control methods and modified ammunition for Avalauncher ammunition are presented. A range of alternative applications for the effects generated by the invention is also disclosed.

DECLARATION FOR PATENT APPLICATION

Docket Number (Optional): 610P002

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled EXPLOSIVE DEVICE PARTICULARLY FOR AVALANCHE CONTROL, the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Not Claimed
			☐
			☐

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application Number)	(Filing Date)	(Status -- patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Kevin S. Lemack, Reg. No. 32,579 Henry C. Nields, Reg. No. 17,029 and Brian M. Dingman, Reg. No. 32,729

Address all telephone calls to Kevin S. Lemack at telephone number (508) 898-1818

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Full name of second joint inventor, if any (given name, family name) _____

Second Inventor's signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

☐ Additional inventors are being named on separately numbered sheets attached hereto.

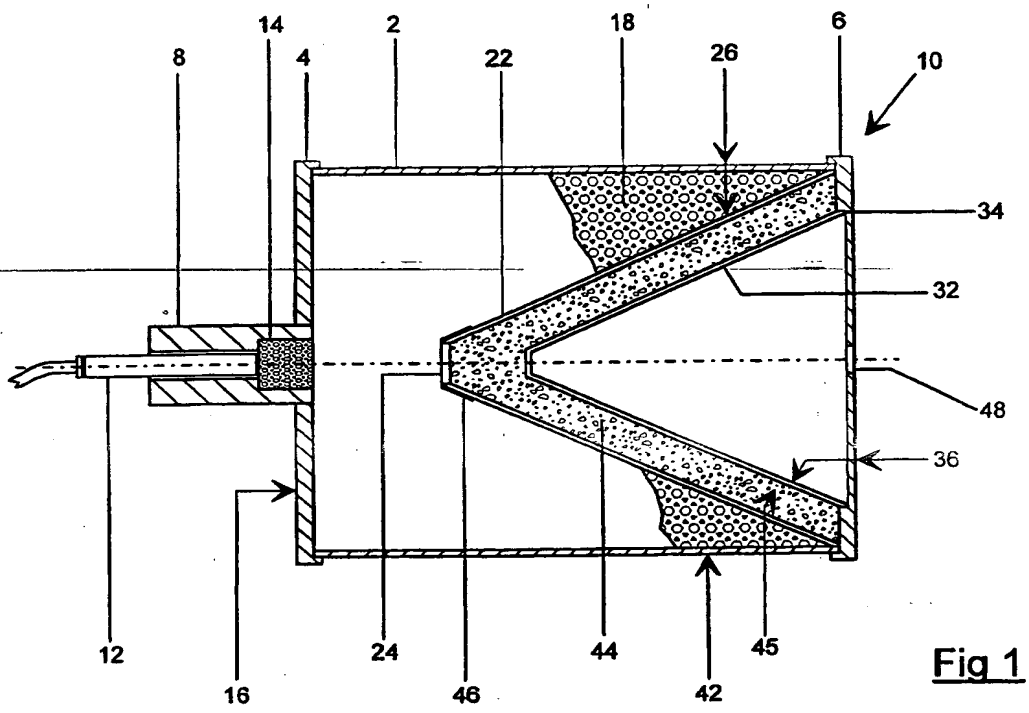
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Fig 1

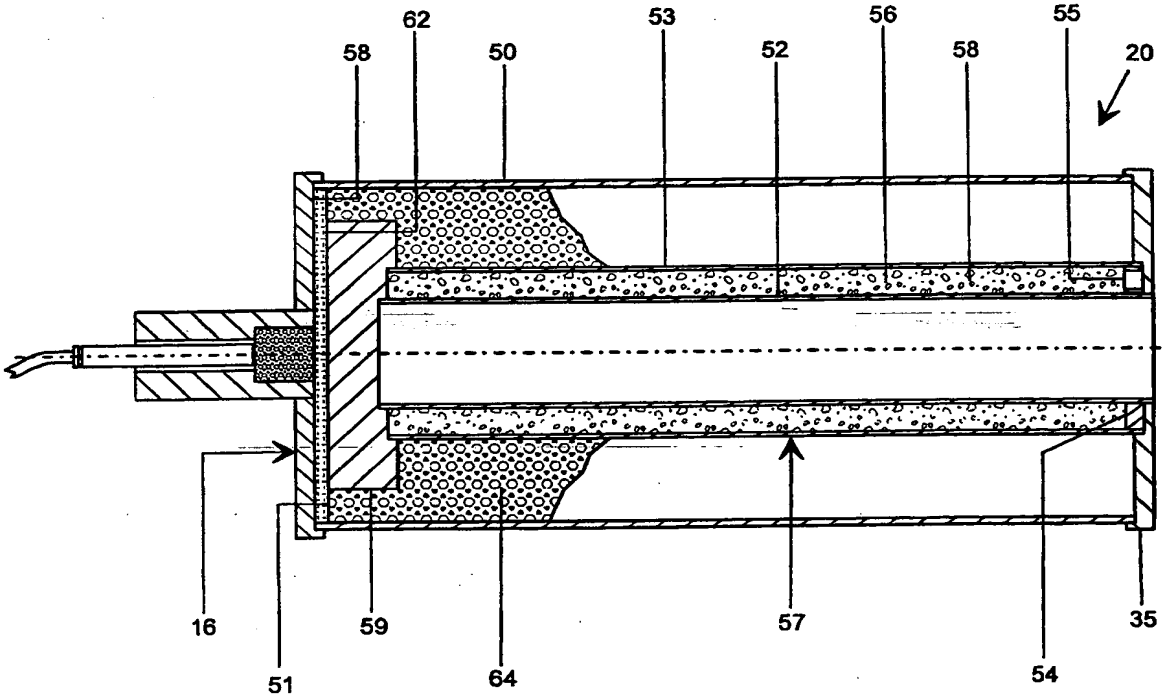
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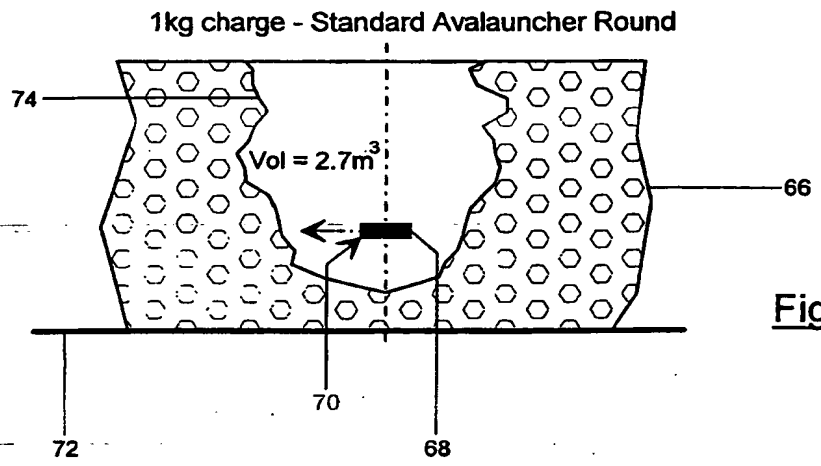
Fig 2



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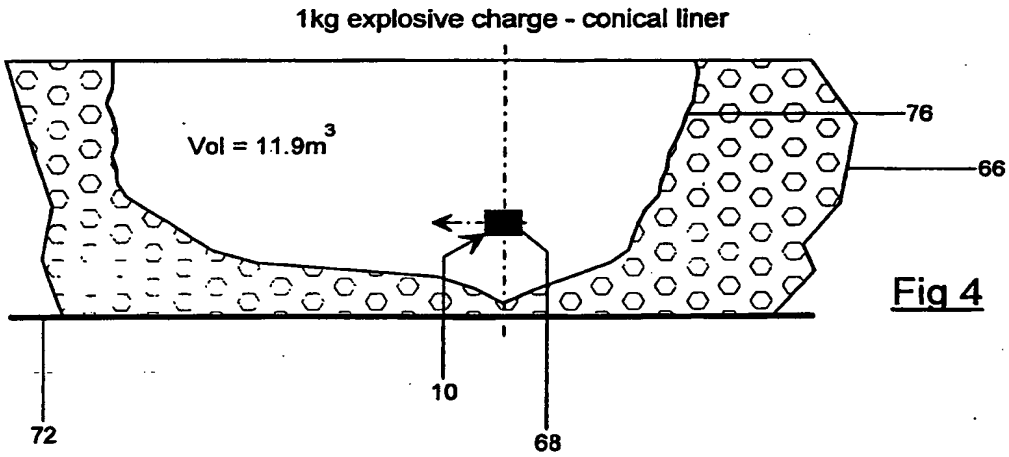

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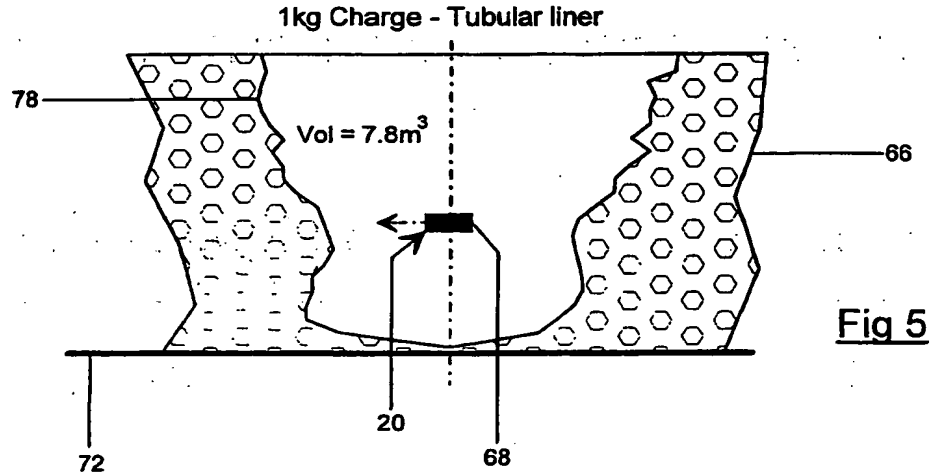

Fig 5

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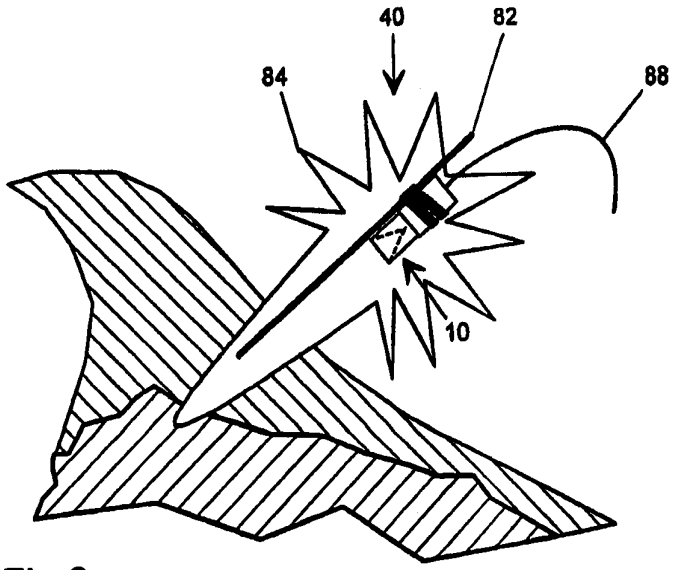

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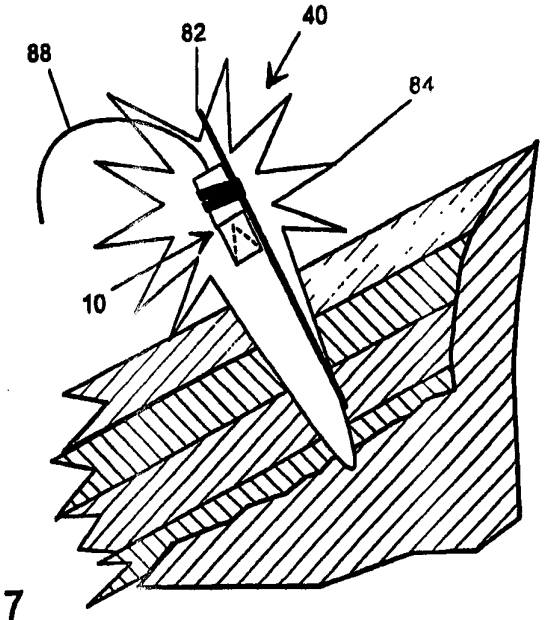

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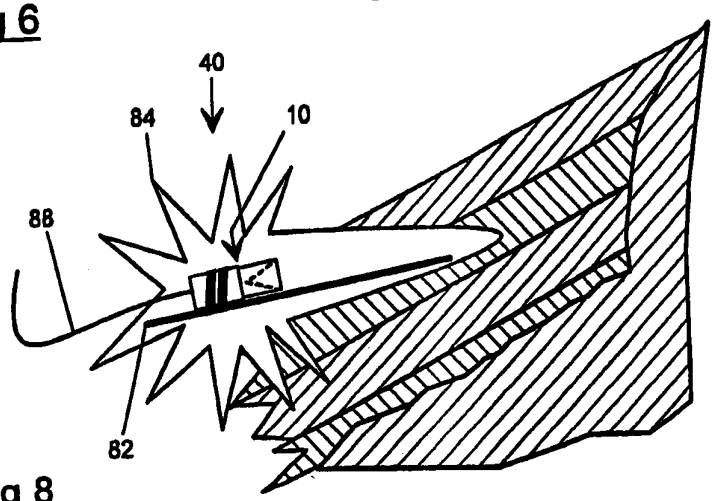

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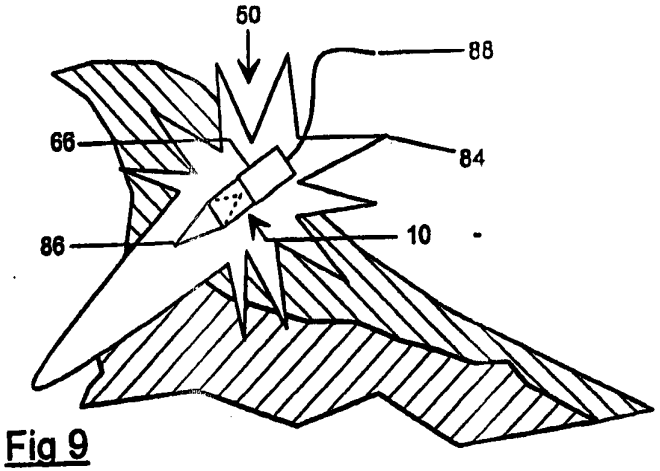


Fig 9

66T00T' h9Z2Th6D

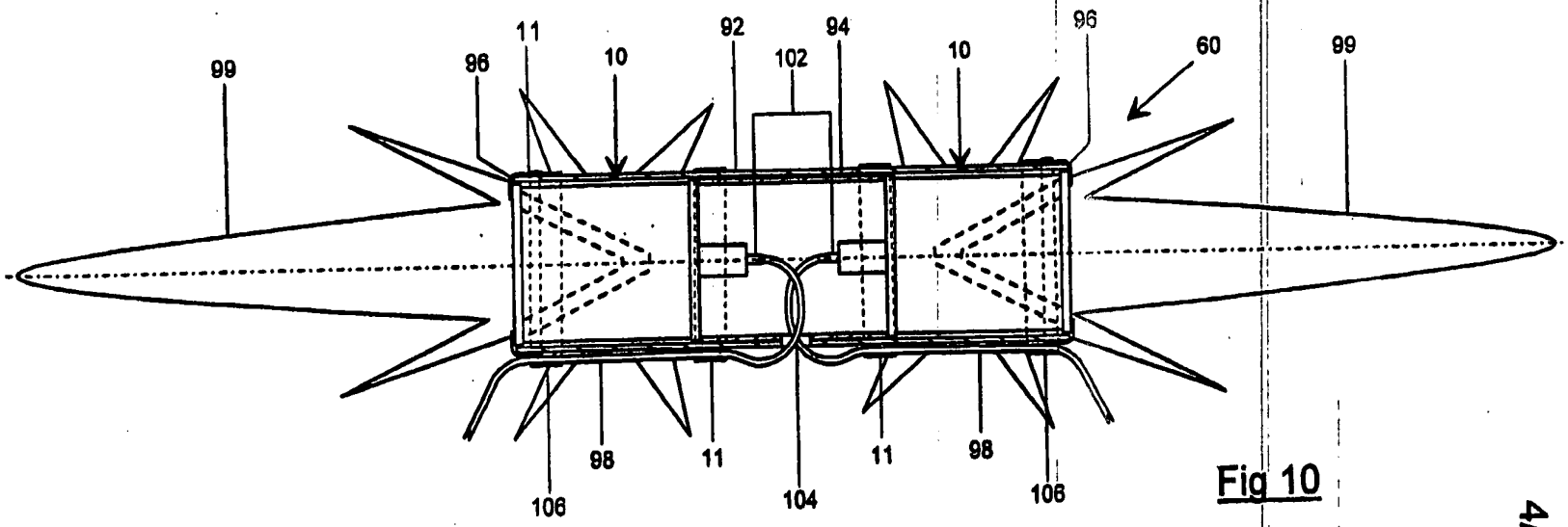


Fig 10

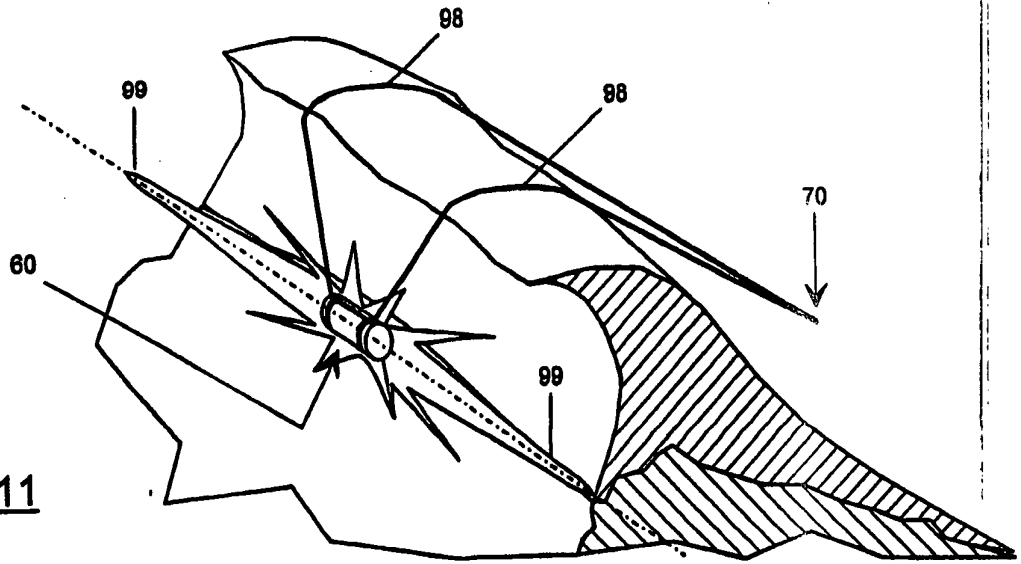


Fig 11

66TOOT'N9Z2TN6O

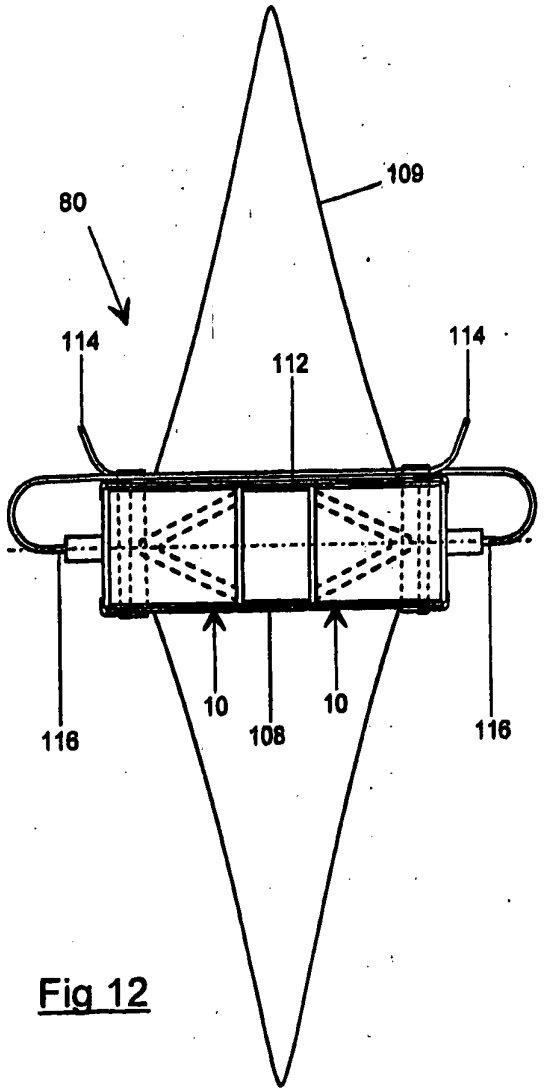
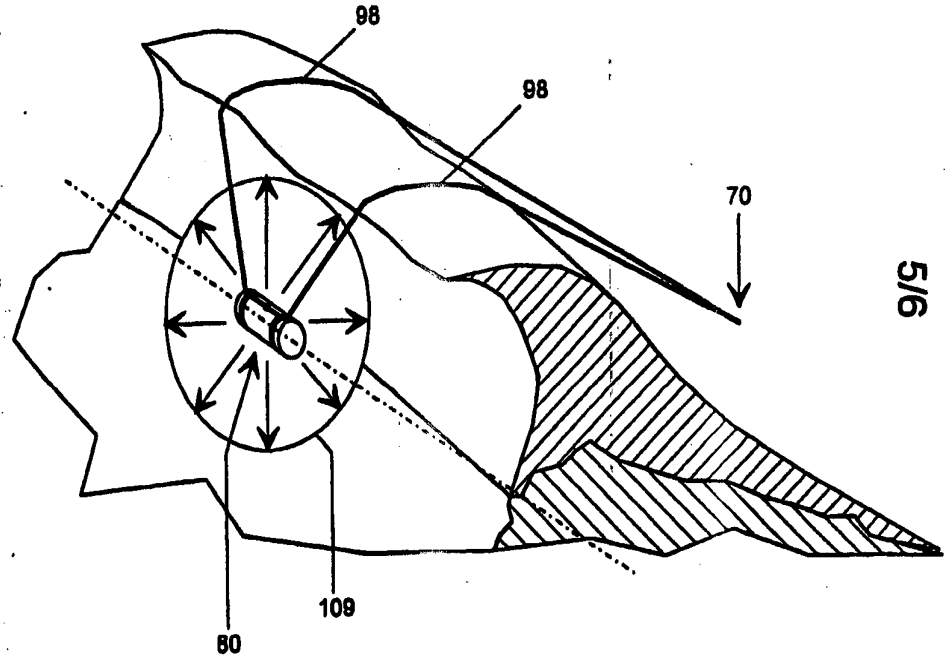


Fig 12



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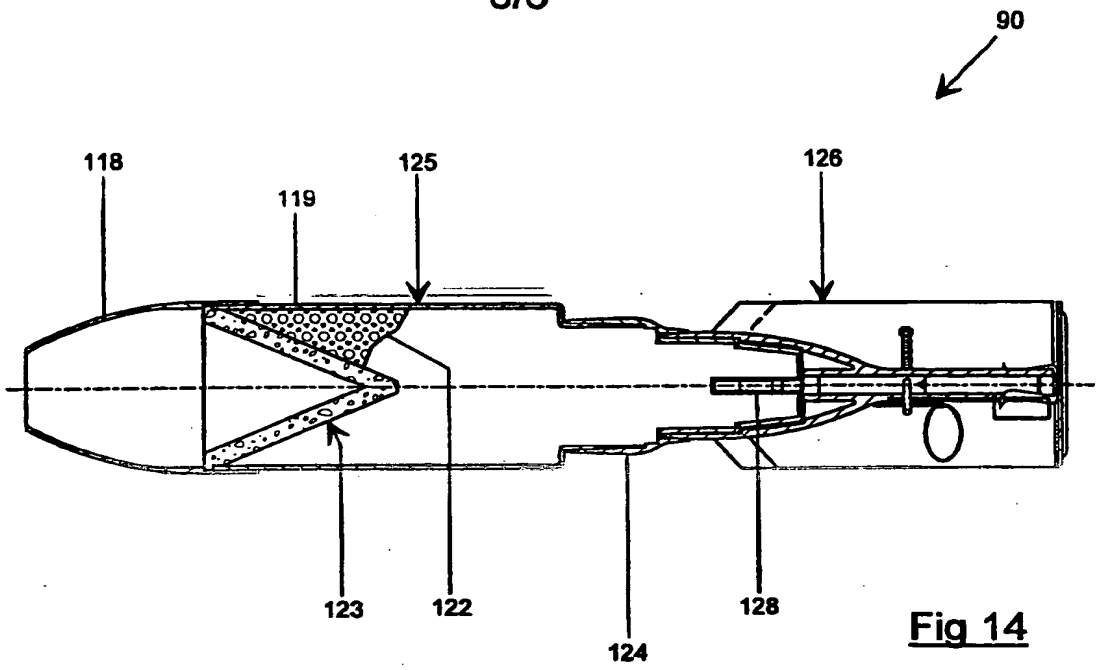

Fig 14

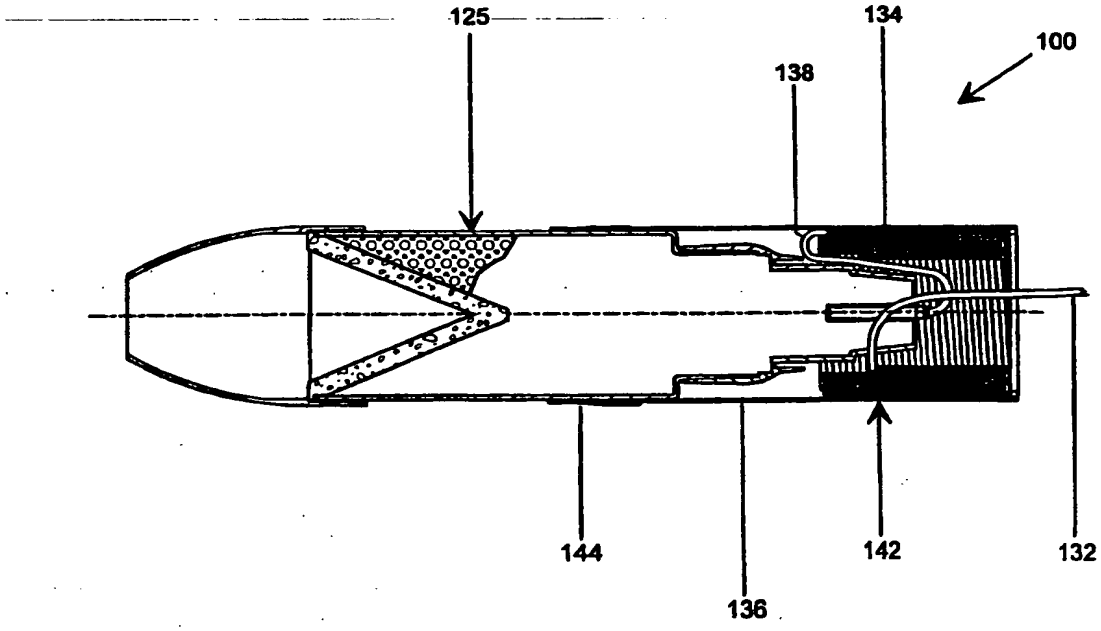

Fig 15

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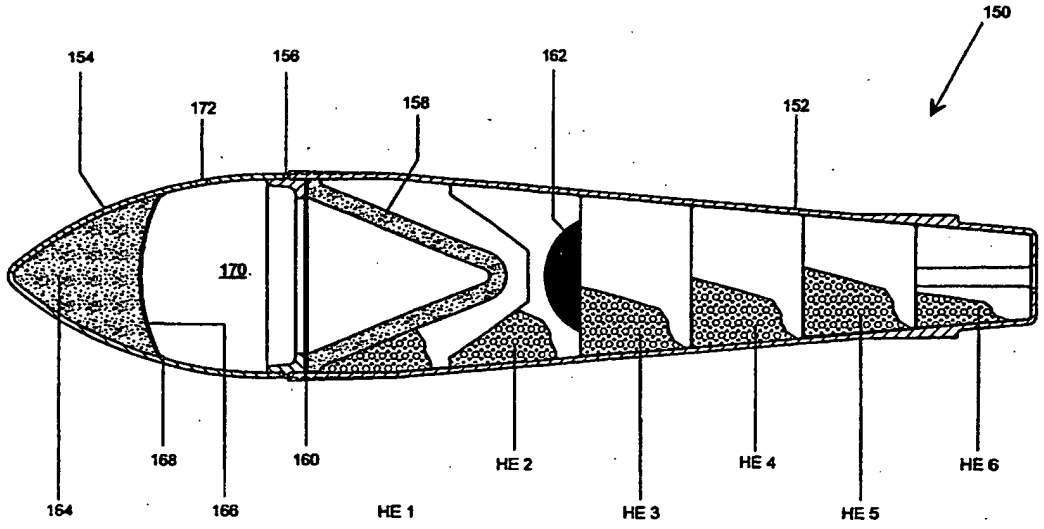
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: HOLLOW CHARGE EXPLOSIVE DEVICE PARTICULARLY FOR AVALANCHE CONTROL



(57) Abstract: A shaped charge explosive device (10) comprising an explosive charge body including an explosive charge (18) defining a cavity particulate material (44) dispersible by the explosive charge when detonated, eg in a liner lining the cavity. In a preferred embodiment of this device of particular applicability to use in avalanche control, the particulate medium is aluminium. This is energised by the liner collapse and jetting process such that on impact and interaction with a snow/ice target it generates a directed blast effect extending beyond that achievable with a simple blast charge of the same mass. Direct application to hand charge avalanche control methods and modified ammunition for Avalauncher ammunition are presented. Two of such charges with a conical liner can be positioned either facing each other or facing away form each other to obtain a particular blast pattern.

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